

### **REMARKS**

Claims 1-22 are now pending in the application. Claim 22 is amended. Claims 23-31 are cancelled without prejudice to the subject matter contained therein. Claims 32-40 are added.

The Examiner is respectfully requested to reconsider and withdraw the rejections in view of the amendments and remarks contained herein.

### **AFFIRMATION OF ELECTION**

Applicant hereby affirms the election of claims 1-22. Claims 23-31 are cancelled without prejudice to the subject matter contained therein.

### **REJECTION UNDER 35 U.S.C. § 102**

Claims 1, 3-11, 14-19, and 22 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Japanese Patent JP 408228910 A (the '910 Patent). This rejection is respectfully traversed.

Various aspects of the present invention relate to a two-way controllable hinge apparatus that includes a hinge pin formed from a two-way shape memory alloy (SMA). The hinge pin can apply two-way reversible actuation forces (e.g., an opening force and a closing force, etc.) to a device (e.g., door, etc.) coupled to the hinge apparatus. Accordingly, the hinge pin can thus provide both the structural requirements needed for a hinge pin and the actuation requirements for controllably positioning a device (e.g., doors, aircraft control surfaces, etc.) coupled to the hinge apparatus.

Independent claim 1 recites a hinge apparatus including a hinge pin formed of a two-way shape memory alloy (SMA). Independent claim 15 recites a method of controllably moving a device in a first direction and a second direction using only one shape memory alloy (SMA), wherein the device is coupled to a hinge apparatus having a hinge pin formed of a two-way SMA.

The '910 Patent does not disclose a hinge pin formed of a two-way SMA. Instead, the '910 Patent merely discloses an automatic lid 2 for a cooking (shabu shabu) pot 1 that opens the pot 1 when food has reached the right temperature. This opening is accomplished by a wire 7 that functions as rotary motor for driving a hinge 6

to open the pot cover 2. But this wire 7 does not appear to be a two-way SMA that can apply torque and perform useful work in either direction.

Further, the wire 7 is not a hinge pin because the wire 7 does not structurally support any component of the hinge 6, as would be required for this wire 7 if it were a hinge pin. Applicant does not believe that the wire 7 could provide any support to the surrounding structure as required of a hinge pin especially considering the relative small wire diameter and manner in which the wire 7 is flexibly curved or bent (as shown in FIGS. 3 and 4 of the '910 Patent). Indeed, the middle wire portions 7A do not appear to be making any contact with the hinge 6. The wire end portions 7B and 7C also appear to be floating within and not secured within the holes 8A and 10B.

Furthermore, the wire concept in the '910 Patent appears to be a low torque device useful only for relatively small torque actuation requirements. But some embodiments of the present invention can generate significant amounts of torque. For example, at least one exemplary embodiment includes a hinge apparatus similar to a typical piano hinge having two leaf panels and a hinge pin attached to the leaf panels. The hinge pin, however, is fabricated from a two-way SMA torque tube that when thermally activated is driven towards a trained shape generating large torques (e.g., 1740 inch\*pounds, etc.) and displacements (e.g., 192 degrees, etc.) which open and close the hinge.

Because the wire 7 in the '910 Patent does not provide any structural support for the hinge 6, the wire 7 is not a hinge pin. Accordingly, Applicant respectfully submits that the '910 Patent fails to disclose a hinge pin formed of a two-way shape memory alloy as recited by independent claims 1 and 15. For at least this reason, the section 102 rejection should be withdrawn.

With regard to dependent claims 3-11, 14-19, and 22, these claims each depend from an independent claim shown above to be allowable. Accordingly, Applicant respectfully submits that claims 3-11, 14-19, and 22 are also in condition for allowance for at least the reasons given above in connection with the independent claim from which they depend.

In addition, claims 3-11, 14-19, and 22 are further patentably distinguishable over the '910 Patent because the '910 Patent does not disclose the additional features required by these claims. For example, the '910 Patent does not appear to disclose:

“making the hinge pin by thermal cycling a material under a sufficient load for a sufficient number of thermal cycles between about the material's austenite and martensite temperatures to complete training of the material, the thermal cycling conditioning the material to transition, without an externally applied load, between an austenitic shape and a martensitic shape to perform useful work when the material is thermally cycled between the austenite and martensite temperatures” (as recited in claim 19); or

“the material is heat treated, prior to said thermal cycling, to establish the austenitic shape and to initiate shape memory effect in the material” (as recited in claim 22).

The Patent Office states that the wire 7 could be formed by thermal cycling, as claimed. But the '910 Patent does not disclose each and every feature in claims 19 and 22, and thus cannot anticipate claims 19 and 22. In addition, the wire 7 does not appear to be a two-way SMA that can apply torque and perform useful work in either direction.

#### **REJECTION OF CLAIMS 12, 13, 20, AND 21 UNDER 35 U.S.C. § 103**

Claims 12, 13, 20, and 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese Patent JP 408228910 A. This rejection is respectfully traversed.

Claims 12, 13, 20, and 21 each depend from an independent claim shown above to be allowable. Accordingly, Applicant respectfully submits that claims 12, 13, 20, and 21 are also in condition for allowance for at least the reasons given above in connection with independent claim from which they depend.

In addition, claims 12, 13, 20, and 21 are further patentably distinguishable over the '910 Patent because the '910 Patent does not disclose, teach, or suggest the

additional features required by these claims. For example, the '910 Patent does appear to disclose:

“the material is thermal cycled for about one thousand or more thermal cycles” (as recited in claims 12 and 20); or

“the load applied to the material during said thermal cycling is about fifty percent more than a predicted working load for the hinge pin” (as recited in claims 13 and 21).

The Patent Office states that the wire 7 could be formed by thermal cycling, as claimed. But the '910 Patent does not disclose, teach, or suggest the features claimed in claims 12, 13, 20, and 21. Further, Applicant submits that the number of thermal cycles and load applied to the material during thermal cycling are novel features that have produced unexpected results, namely the ability to produce stable, robust, and predictable two-way SMA parts capable of performing useful and significant work over numerous (e.g., thousands) thermal cycles during both the austenite-to-martensite transition and the martensite-to-austenite transition.

For these additional reasons, the Patent Office is respectfully requested to reconsider and withdraw the section 103 rejections of claims 12, 13, 20, and 21.

#### **REJECTION OF CLAIMS 1-11, 14-19, AND 22 UNDER 35 U.S.C. § 103**

Claims 1-11, 14-19, and 22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Japanese Patent JP 2000164309 A (the '309 Patent) in view of Jacot et al., U.S. Patent 6,065,934 (Jacot). This rejection is respectfully traversed.

Independent claim 1 recites a hinge apparatus including a hinge pin formed of a two-way shape memory alloy (SMA). Independent claim 15 recites a method of controllably moving a device in a first direction and a second direction using only one shape memory alloy (SMA), wherein the device is coupled to a hinge apparatus having a hinge pin formed of a two-way SMA.

Neither the '309 Patent nor Jacot teaches or renders obvious a hinge pin formed of a two-way SMA. Instead, the '309 Patent merely discloses an SMA plate 20 (FIGS. 2A and 2B) positioned adjacent a rotary shaft 4 (FIGS. 1A and 1B). The SMA plate 20

closes (FIG. 2B) when heated to close the depression section 6, which in turn, causes the semiconductor input/output terminals 9 to be depressed to the connector terminals 12. The SMA plate 20 is not a hinge pin. In addition, this SMA plate 20 does not appear to be a two-way SMA that can apply torque and perform useful work in either direction. Further, the SMA plate concept also appears to be a low torque device useful only for relatively small torque actuation requirements.

Jacot describes a rotary actuator 18 that includes opposing one-way SMAs 24 and 26. But neither of these two opposing one-way SMAs are a hinge pin. In addition, the SMA return spring 26 applies an external load to help the SMA torque tube 24 return to its twisted shape after the application of heat has been discontinued. Therefore, even if the Jacot SMA torque tube 24 were substituted for the rotary shaft 4 in the '309 Patent, this modified device would still not include a hinge pin formed of a two-way SMA adapted to transition, without an externally applied load, between a first trained shape and a second trained shape (as recited in claim 1). In addition, the Jacot torque tube 24 would also likely be too expensive and too bulky to include in the semiconductor device 8 of the '309 Patent, and it also unclear how a torque tube would operate to transfer the needed torque to depression section 6 in the '309 patent.

Jacot's antagonistic design in which the SMA return spring 26 is used to impress a load to convert the SMA torque tube 24 between states teaches away and does not render obvious a method of controllably moving a device in a first direction and a second direction using only one SMA (as recited in claim 15). See MPEP § 2145. In some embodiments of the present invention, a single SMA is used for controllably moving a device, which, in turn, eliminates the need for an additional actuator and the associated mechanical mechanisms saving significant space, weight, and system complexity.

The Patent Office notes that the '309 Patent does not teach a hinge pin being a torque tube. The Patent Office then states that it would have been obvious to include in the design of the '309 Patent a modification as taught by Jacot for the purpose of providing an alternative actuation device for producing desired rotary motion. But as noted above, a hinge pin formed of a two-way SMA is not disclosed or taught by either the '309 Patent or Jacot. Therefore, even if it were proper to combine the '309 Patent

with Jacot, this combination would still not satisfy each and every feature of claims 1-11, 14-19, and 22.

Because the '309 Patent and Jacot, alone or in combination, do not disclose, teach or suggest a hinge pin formed of a two-way SMA, the '309 Patent and Jacot cannot render obvious claims 1-11, 14-19, and 22. For at least this reason, the Patent Office is respectfully requested to reconsider and withdraw the section 103 rejections of claims 1-11, 14-19, and 22.

#### **NEW CLAIMS 32 THROUGH 40**

Claims 32-40 are added. New claims 32-40 are supported by the application as originally filed. Accordingly, no new matter is introduced by the addition of claims 32-40.

#### ***Claims 32-34***

In addition, claims 32-34 each depend from independent claim 1 shown above to be allowable. Accordingly, Applicant respectfully submits that claims 32-34 are each in condition for allowance for at least the reasons given above in connection with independent claim 1. That is, none of the cited references disclose, teach or suggest an a two-way SMA hinge pin.

In addition, claims 32-34 are further patentably distinguishable over the cited references in that the cited references do not disclose, teach or suggest the additional features required by claims:

“the hinge pin is configured to apply torque within a range of about 27 inch pounds and about 1740 inch pounds” (as recited in claim 32); or

“the hinge pin is configured to apply torque within a range of about 27 inch pounds and about 1010 inch pounds” (as recited in claim 33); or

“the hinge pin is configured to apply torque within a range of about 1010 inch pounds and 1740 inch pounds” (as recited in claim 34).

As noted above, the one-way SMA wire 7 in the '910 Patent and the one-way SMA plate 20 in the '309 patent both appear to be low torque devices incapable of producing torques within the ranges as claimed in claims 32-34.

### ***Claims 35-40***

Claims 35-40 are patentably distinguishable over the cited references in that the cited references do not disclose, teach or suggest a piano hinge that includes a two-way shape memory alloy (SMA) positioned along the hinge line, as recited in claim 35.

As noted above, the '910 Patent merely discloses an automatic lid 2 for a cooking (shabu shabu) pot 1 that opens the pot 1 when food has reached the right temperature. This opening is accomplished by a wire 7 that functions as rotary motor for driving a hinge 6 to open the pot cover 2. The hinge 6, however, is not a piano hinge. And, the wire 7 does not appear to be a two-way SMA that can apply torque and perform useful work in either direction.

Further, the '309 Patent merely discloses an SMA plate 20 (FIGS. 2A and 2B) that closes (FIG. 2B) when heated to close a depression section 6. The '309 Patent does not disclose a piano hinge. Plus, the SMA plate 20 does not appear to be a two-way SMA that can apply torque and perform useful work in either direction.

And, Jacot also does not describe a piano hinge having a two-way SMA positioned along the hinge line. Instead, Jacot describes a rotary actuator 18 that includes opposing one-way SMAs 24 and 26. In Jacot's antagonistic design, the SMA return spring 26 is used to impress a load to convert the SMA torque tube 24 between states.

In addition, claims 36-40 are further patentably distinguishable over the cited references in that the cited references do not disclose, teach or suggest the additional features required by these claims:

“hinge leafs having alignable knuckles to define a passage into which the two-way SMA fits, and a key-spline arrangement for transfer of torque from the two-way SMA to the appropriate leaf” (as recited in claim 36); or

“the two-way SMA is configured to apply torque within a range of about 27 inch pounds and about 1740 inch pounds” (as recited in claim 37); or

"the two-way SMA is configured to apply torque within a range of about 27 inch pounds and about 1010 inch pounds" (as recited in claim 38); or

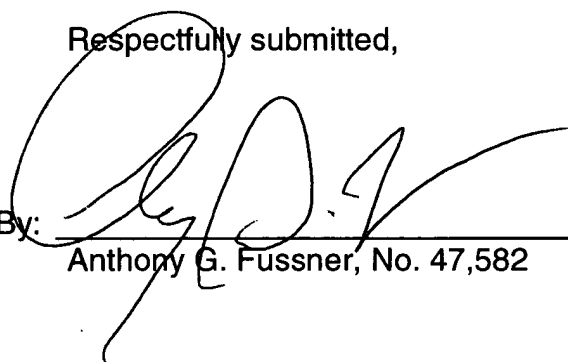
"the two-way SMA is configured to apply torque within a range of about 1010 inch pounds and 1740 inch pounds" (as recited in claim 39); or

"the two-way SMA hinge is configured to apply torque at about 1740 inch pounds" (as recited in claim 40).

### **CONCLUSION**

It is believed that all of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action, and as such, the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned directly at (314) 726-7502.

Respectfully submitted,

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